

Application No.: 10/522,887
Amendment under 37 CFR 1.111
Reply to Office Action dated June 4, 2007
December 4, 2007

AMENDMENTS TO THE SPECIFICATION

Please substitute the paragraph beginning at page 3, line 6 and ending at page 4, line 15 to read as follows:

-- The semiconductor light-emitting device 10000 has a structure including a luminescent layer 4 disposed between a first conductivity type layer 2 and a second conductivity type layer 3. At least part of the structure defines a structured portion 10 which has a lower surface 10g with a width and an upper surface 10f with a smaller width than that of the lower surface 10f in sectional view, and inclined opposing side surfaces: first side surfaces 10x; and second side surfaces 10y. The width of the first side surfaces 10x increases from the lower surface 10g side toward the upper surface 10f; the width of the second side surfaces 10y increases from the upper surface 10f side toward the lower surface 10g. More specifically, the structured portion 10 of the device has the lower surface 10a and the upper surface 10f with a smaller area than that of the lower surface 10g, and the side surfaces 10x between the dotted chain lines 10x-1 and 10x-2 define the corners 10g-x and 10f-x of the structured portion 10 of the device and have a width increasing

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toward the upper surface 10f from the lower surface 10g, as shown in Figs. 53A and 53C. On the other hand, the side surfaces 10y are formed so as to have a width decreasing toward the upper surface. Thus, the widths of the side surfaces 10x and 10y are varied in reverse to each other in the height direction (toward the upper surface) of the structured portion, that is, the width of the side surfaces 10x is increased; the width of the side surfaces 10y is reduced. Accordingly, the proportion of lengths of the sides defining a plane at a certain height (a plane parallel to the upper surface of the structured portion or a plane having a normal in the height direction) varies, and the proportion of occupancies of the side surfaces above the plane also varies. Consequently, reflection of light emitted from the light-emitting device, designated by the arrows in Fig. 53B, from the side surfaces to the lower surface is diffused, as shown in Fig. 53B. Thus, the light-emitting device exhibits superior uniformity and light extraction though, in light-emitting devices, light is generally liable to be concentrated. --

Please substitute the paragraph beginning at page 32, line 9 and ending at page 33, line 11 to read as follows:

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-- Preferably, the periphery includes second side surfaces 10y having a width decreasing from the lower surface 10g toward the upper surface 10f, and the first side surfaces 10x having a width decreasing in the opposite direction. In this instance, according to the shape of the upper surface, the side surface 10y with a longer base (side 10g-1) on the lower surface 10g side may be changed into such a shape as the sides 10x-1 and 10x-2 being the boundaries between the first and the second side surfaces disappear on the way from the lower base to the upper base, as shown in Fig. 53C; hence, the second side surface does not necessarily reach to the upper surface. Thus, the upper surface 10f and the lower surface 10g may have different shape, as defined by the dotted line 10f and 10g in Fig. 53C. The side surfaces may be sufficiently curved at the upper surface side to be circular. The upper surface 10f and the lower surface 10g are provided in desired vertical positions of the structured portion. Preferably, the entirety of a protrusion corresponding to the layered structure of a device defines the structured portion of the present invention. More preferably, the divergent first side surface having a width increasing toward the upper surface may be curved outward to have a convex surface, thereby ensuring superior reflection and diffusion of light and precision of mask formation.

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The proportion of the lengths of the upper bases 10f-x and 10f-1 or lower bases 10g-x and 10g-1 of the first side surface 10x to the second side surface 10y is not particularly limited. For forming a suitable shape of the protrusion, however, it is preferable that both the upper base 10f-x and the lower base 10g-x of the first side surface be shorter than ~~these~~ the upper base 10f-1 and the lower base 10g-1 of the second side surface. --

Please substitute the paragraph beginning at page 36, line 23 and ending at page 37, line 9 to read as follows:

-- In a known structure shown in Fig. 21, light emitted from the luminescent region leaks to an n type contact layer 512 between the substrate 1 and an n electrode 521, and the light repeatedly reflect from the upper surface of the substrate 1 and the rear surface of the n electrode 121 (as schematically shown with reference numeral Y100 in Fig. 21). Thus, most of the light is absorbed by the n electrode 121 and cannot be extracted to the outside. On the other hand, in the present invention, the ohmic contact of the n electrode is established on the surface 12a of the n-type contact layer 12 exposed at the inclined periphery 10a, thus preventing the n-type contact layer 12 from

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transmitting light (as schematically shown with reference numeral Y1 in Fig. 2). Thus, the conventional problem is overcome. --

Please substitute the paragraph beginning at page 52, line 15 and ending at page 52, line 25 to read as follows:

-- After forming the n ohmic electrodes 321a, n connecting pad electrodes 321b, over-surface electrodes 331, and p pad electrodes 332 as described above, an insulating layer 371 is formed to cover the entire device except the upper surfaces of the connecting pad electrodes 321b, their surroundings, and the p pad electrodes 332. Then, p connecting electrodes 361 are formed to connect the p pad electrodes 332 of the layered portions 310 to each other. The p connecting electrode 361 includes a pad connecting portion 361b connected to the upper surface of the p pad electrode 332 and a connecting portion [[361]] 361a connecting the pad connecting portion 361b to another pad connecting portion. --

Please substitute the paragraphs beginning at page 57, line 14 and ending at page 57, line 24 to read as follows:

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-- Also, the over-surface electrode is provided over substantially the entire upper surface (upper surface of the p contact layer) of each layered portion 610, and a circular p pad electrode 632 is formed in the center of the over-surface electrode. The p pad electrodes 632 of the layered portions 610 are connected to each other with p connecting electrodes [[361]] 661.

The n electrode including the n ohmic electrodes 621a and the n connecting pad electrodes 621b is electrically insulated from the p electrode including the over-surface electrodes 631, the p pad electrodes 632, the p connecting electrodes [[361]] 661, as in Embodiment 6. --

Please substitute the paragraph beginning at page 60, line 8 and ending at page 60, line 23 to read as follows:

-- In the nitride semiconductor light-emitting device of Embodiment 8, a luminescent layer 4 is disposed between a n-type nitride semiconductor layer 2 and a p-type semiconductor layer 3 to define a double heterostructure luminescent region. The p-type nitride semiconductor layer, the luminescent layer, and part of the n-type nitride semiconductor layer are formed in frustum

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shapes. In other words, the third aspect of the present invention leads to a device having a frustum layered composite including at least a p-type nitride semiconductor layer and a luminescent layer. A p-type ohmic electrode 36 is formed over substantially the entire surface of the p-type nitride semiconductor layer 3 of the layered composite 10, and an insulating layer 72(5) covering the surroundings of the p-type ohmic electrode 36, the inclined periphery 10a of the layered composite 10, and the n-type semiconductor layer 2 (8b) continuing to the periphery 10a. --

Please substitute the paragraphs beginning at page 64, line 22 and ending at page 65, line 6 to read as follows:

-- Then, wiring electrodes ~~[[65]]~~ 62 are formed between the layered portions 10 as required (Fig. 39).

Subsequently, a reflection layer ~~65(6)~~ 62(6) is formed. The reflection layer 6 is made of a light-reflective material, such as Ag, Pt, Rh, or Al. For a light-emitting device including a plurality of the layered portions, the reflection layer 6 may double as the wiring electrode. In particular, since the reflection layer is provided so as to oppose the inclined

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peripheries of the frustum layered composites, the efficiency in use of light can be dramatically increased. --

Please substitute the paragraph beginning at page 82, line 21 and ending at page 83, line 4 to read as follows:

-- For wiring the electrodes, each electrode preferably has an ohmic contact portion where an ohmic contact is established to supply current in the structure portion of the device. Preferably the electrodes (wiring electrode and pads) are formed corresponding to the ohmic contact portions. Alternatively, the wiring electrode may be provided so that separated ohmic contact portions electrically conduct to one another. The wiring electrode 1120 or 766 may be provided to a device-mounting base, as described later. --

Please substitute the paragraph beginning at page 100, line 2 and ending at page 100, line 20 to read as follows:

-- If the multilayer board 10400 in the present invention is bonded opposing the electrodes of the light-emitting device 10000, electrode structures 11200a and 11200b or 766 are provided

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to the board 10400 corresponding to the electrodes 21 (29) and 31 (32) of the light-emitting device 10000. If the board 10400 is bonded opposing the opposite side (substrate 400) to the electrodes of the light-emitting device 10000, an adhesion layer or the like for bonding is provided instead of the electrodes, but another type of electrode may be provided for connecting the board to the light-emitting device 10000 by wiring. The electrodes 11200 of the board 10400 may be provided only on the surface bonding to the light-emitting device 10000, as shown in the figures. Alternatively, the electrodes may be provided, as a mounting-surface electrodes 11400, on the mounting surface opposing the bonding surface of the board 10400 such as to extend from the bonding surface to the mounting surface, to lie on the bonding surface, or to be communicated or electrically coupled from the bonding surface of the light-emitting device to the mounting surface through a through hole or via hole. --

Please substitute the paragraph beginning at page 101, line 21 and ending at page 103, line 5 to read as follows:

-- A light-transforming member 10600 and a light-transforming layer 23100 in the light-emitting apparatus 20000

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absorb part of the light from the light-emitting device 10000 and emit light having a different wavelength. A material containing a phosphor may be used as the light-transforming member or layer. The light-emitting transforming member 10600 and the light-transforming layer 23100 may be formed as the coating 10500 by coating the entirety or a part of the light-emitting device 100000, or by coating part of the multilayer board 10400 together with the light-emitting device. In the above-described first to third aspect, the light-transmissive member or layer may be formed not only in the light-transmissive protection layer coating the structured composite or the like, but also in an optical path running from the light-emitting device, for example, in a light-transmissive member (lens 24000 or filler). Binders of the phosphor include: oxides and hydroxide containing at least one element selected from the group consisting of Si, Al, Ga, Ti, Ge, P, B, Zr, Y, Sn, Pb, and alkaline-earth metals; and organic metal compounds (preferably containing oxygen) containing at least one element selected from the group consisting of Si, Al, Ga, Ti, Ge, P, B, Zr, Y, Sn, Pb, and alkaline-earth metals. The organic metal compounds include compounds having an alkyl group or an aryl group, such as metal alkoxides, metal diketonates, metal diketonate complexes, and metal carboxylates.

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The light-transforming member or layer may be formed as part of a sealing member 23000 (24000) of the light-emitting apparatus 20000, or formed as an additional layer 23100 on a sealing member 23000a or between the sealing member 23000a and a sealing member 23000b, separate from the light-emitting device 10000, as shown in Fig. 56. The light-transforming member may be dispersed in the sealing member 23000, or the light-transforming layer 23100 may serve as the sealing member 23000. Also, the light-transforming member or layer may be formed in a layer sedimented in a apparatus base 22000, the mounting base 20100, or the housing recess 20200. --

Please substitute the paragraph beginning at page 112, line 17 and ending at page 113, line 8 to read as follows:

-- Embodiment 11 is involved in the light-emitting apparatus 20000 in which the light-emitting device 10000 is mounted in the mounting base 21000 isolated from the lead 21000, using the adhesion member 20400, as shown in Fig. 55. The housing recess 20100 of the light-emitting device 10000 is provided with the reflector 20300, and may be connected to an external heat radiator to serves as a heat radiator 20500. The light-emitting

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device 10000 is electrically connected to the internal lead 21100 with a wire 25000, and the lead 21000 is extended to the outside to establish electrical connection. By separating the mounting base 20100 from the lead 21000, the light-emitting apparatus comes to ease of thermal design. The recess 20200, the reflector 22100 of the base 22000 (22000a and 22000b), and the terrace 22200 are sealed with the light-transmissive sealing member 23000 as shown in Fig. 56. By providing an optical lens to the sealing member 23000, or by forming the sealing member 23000 into a lens 24000, light emission having a desired directivity can be obtained. --